PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G01L 5/22, G01M 17/00, E05B 17/00 — A1

(11) International Publication Number: WO 00/40940

(43) International Publication Date: 13 July 2000 (13.07.00)

(21) International Application Number: PCT/GB00/00027

(22) International Filing Date: 7 January 2000 (07.01.00)

(30) Priority Data:

9900336.0	8 January 1999 (08.01.99)	GB
9909016.9	21 April 1999 (21.04.99)	GB
9921100.5	8 September 1999 (08.09.99)	GB

(71) Applicant *(for all designated States except US)*: MERITOR LIGHT VEHICLE SYSTEMS (UK) LIMITED [GB/GB]; Fordhouse Lane, Birmingham B30 3BW (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: FISHER, Sidney, Edward [GB/GB]; 85 Newborough Road, Shirley, Solihull, West Midlands B90 2HB (GB). FAUVEAU, Axel [GB/GB]; 19 Dunslade Crescent, Quarry Bank, Brierley Hill, West Midlands DY5 2EA (GB).

(74) Agent: BARKER BRETTELL; 138 Hagley Road, Edgbaston, Birmingham B16 9PW (GB).

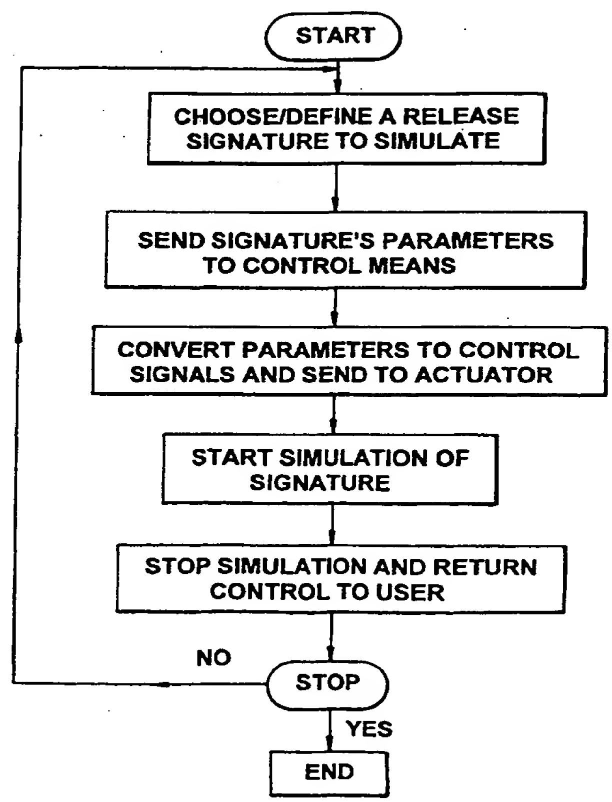
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A METHOD OF DETERMINING WHETHER A MOVABLE COMPONENT OF AN APPARATUS MEETS PREDETERMINED MOVEMENT CHARACTERISTICS

(57) Abstract

A method of determining whether an apparatus having a movable component meets predetermined movement characteristics, the method comprising the steps of: establishing a predetermined movement signature for said movable component; moving said movable component through a distance; measuring the movement signature of the movable component; establishing whether the measured movement signature matches the required predetermined movement signature to within acceptable limits. The methods is particularly intended to be applied to the field of vehicle door latch mechanisms to establish whether or not the latch mechanism functions as desired, but can be applied to other mechanisms.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

A METHOD OF DETERMINING WHETHER A MOVABLE COMPONENT OF AN APPARTUS MEETS PREDETERMINED MOVEMENT CHARACTERISTICS

The present invention relates to an apparatus for the simulation and measurement of one or more operation characteristics of a device especially, but not exclusively, for the automotive industry, and particularly, but not exclusively, to the measurement and simulation of a user-manipulated force-distance operation characteristic, such as the release signature of automotive vehicle door latch mechanisms.

The invention arose as a result of work in the field of vehicle door latch mechanisms, and will be described in relation to that context, but as will be appreciated, it has much wider applications.

By vehicle door latch mechanism is meant a mechanism for opening/closing a vehicle door and for retaining the door in a closed position, having a manually-operated release handle and a movable latch adapted to cooperate with a latching component on the vehicle frame and a mechanical linkage between the handle and the latch.

There are many applications in the construction of automotive vehicles such as cars, lorries or vans, where it is desirable to simulate/measure one or more operation characteristics of a device of the vehicle. For example, for latch mechanisms of vehicle doors the "feel" of the handle as it is operated is important. Some customers believe that the handle should neither be too loose or too stiff, and the operation thereof should preferably be smooth throughout with no sudden changes of the force necessary to operate the handle and latch mechanism. The feel is at least in part determined by the force that needs to be applied to the handle as a function of the distance the handle is moved from its inoperative position.

This force versus distance curve is known as the release signature curve of the handle. This varies for latch mechanisms for different doors, and from mechanism to mechanism for the same type of door depending on, for example, small changes in the mechanism and/or the pressure exerted by a resilient seal provided at the door of the vehicle.

When designing and manufacturing latch mechanisms for vehicle doors, it is usual for the customer to specify one force versus distance point which the handle must meet: a single point on a force-distance graph. The remainder of the latch mechanism release signature has hitherto not been quantified as such, the operation of the latch mechanism not being metrically defined. The design of latch mechanism is determined by the "feel" of the handle to the customer. This is clearly very subjective, and can be difficult for the manufacturer to reproduce accurately and consistently. The customer's perception of the feel of the handle may also change. Once the design of a door has been finalised it is difficult and expensive to change the door or even the panels of the door. If the door design is changed during development and after modification of the door the feel of the handle, after manufacture and instalment in the door, proves unsatisfactory to the customer, the design of the latch then requires modification which is undesirable for the manufacturer of the latch mechanism.

According to a first aspect of the invention we provide a method of determining whether an apparatus having a movable component meets predetermined force -vs- distance characteristics, the method comprising the steps of:

establishing a predetermined force-distance signature for said movable component;

moving said movable component through a distance;

measuring the force-distance signature of the movable component;

establishing whether the measured force-distance signature matches the required predetermined force-distance signature to within acceptable limits.

Preferably the component is moved by human action, preferably by the hand or foot.

The predetermined force-distance signature may be determined by moving the movable component of an acceptable apparatus through said distance whilst measuring the force-distance signature of the movable component. The predetermined force-distance characteristic signature may be created by inputting data to a memory using one or more of: a keyboard, a graphic interface, user-manipulated electronic input, or indeed electronic transfer of data (or, in any other way). The predetermined force-distance characteristic signature may be created using a computer simulation. The predetermined force-distance signature has a plurality of points on the force-distance graph, typically at least three points.

We may determine whether a user/driver-operated component meets a predetermined force-distance characteristic. Preferably the user/driver-operated component comprises one or more of the following:-

a) a door latch mechanism
b) a hand brake mechanism
c) a clutch assembly/clutch pedal assembly
d) a footbrake assembly/footbrake pedal assembly
e) an acceleration pedal assembly

f) a gear stick assembly/gearbox assembly

g) a sunroof moving mechanism

h) a window moving mechanism.

i) a steering wheel

j) an indicator-actuating assembly

k) a switch assembly (such as a push, deflect, or twist switch)

l) a glove box latch

m) a boot, bonnet or hood release latch assembly

n) a fuel flap release assembly.

Preferably the movable component is biased by a spring or other resilient or biasing means, and in which the movement of the movable component is influenced by said spring or other resilient or biasing means. The component may be moved against the force of said biasing means. The movable component may be moved through said distance by automated component-moving means. A processor may compare the measured force-distance signature with a predetermined allowable signature from memory. The processor also preferably controls the movement of the movable component.

In the above method, the rate at which the movable component is moved can be important. When measuring the force –distance signature of the component, the result obtained will depend on the rate of moving the component, for example, a different result will be obtained if the component is moved quickly from that obtained when it is moved more slowly. This is due, at least in part, to the inertia of the components of the apparatus. It is desirable to take this into account. When, for example, a vehicle latch mechanism is being designed for a customer, it is desirable to agree not only the release signature for the mechanism, but

also the rate of operation of the mechanism at which this release signature should be achieved.

The method may comprise establishing a predetermined rate of moving the movable component or a predetermined force to be applied to the component as a function of time (F(t)), moving the movable component at that rate or F(t) or a rate or F(t) within acceptable limits thereto, and establishing whether the measured force-distance signature matches the required predetermined force-distance signature to within acceptable limits at the rate of moving or the F(t) applied to the component. The method may comprise determining whether the movable component is moved at the predetermined rate or F(t) of moving or a rate within acceptable limits thereto. The predetermined rate of moving or the force applied as a function of time may be constant or may be variable.

The predetermined rate of moving may be defined in terms of a force-time signature (i.e. force vs time characteristics) of the movable component. The predetermined force-time characteristic signature may be created by inputting data to a memory using one or more of: a keyboard, a graphic interface, user-manipulated electronic input, or indeed electronic transfer of data (or, in any other way, for example by loading a machine readable data carrier). The predetermined force-time characteristic signature may be created using a computer simulation. The predetermined force-time signature preferably has a plurality of points on the force-time graph, typically at least three points.

According to a second aspect of the invention, we provide a force -vs- distance measuring apparatus adapted to determine whether a movable component has a predetermined acceptable force -vs- distance movement characteristic: the apparatus comprising signature capture means for

measuring the force-distance signature of said component; and comparator means adapted to compare the captured or measured force -vs- distance signature with an allowable force -vs- distance signature.

The apparatus may have a movable component coupled to it.

The apparatus may comprise response means adapted to respond in different predetermined ways if a component either meets the predetermined requirements or if it fails to meet the requirement.

The apparatus may be arranged to operate in accordance with the preceding method.

Again, the rate at which the movable component is moved can be important. The apparatus may comprise means for enabling the movable component to be moved at a predetermined rate of moving or at a predetermined force as a function of time (F(t)) or at a rate or a F(t) within acceptable limits thereto. The apparatus may comprise means for determining whether the movable component is moved at the predetermined rate of moving or at the predetermined F(t) or a rate or a F(t) within acceptable limits thereto. The apparatus may comprise force–time measurement means adapted to be connected to the movable component which measures the force on the component as a function of time. The force-time measurement means may comprise a transducer. The transducer may measure the force on the component as a function of time i.e. may measure the force and the time at/for which the component experiences that force. Alternatively, the transducer may measure the force/forces experienced by the component, and an additional time measurement means may be provided to measure the time at/for which the component experiences a particular force. The time measurement means

may be a computer. The force-time measurement means may further comprise means which receive the force and time measurements and generates a force-time signature/graph therefrom. The determining means may comprise force-time measurement means.

According to a third aspect of the invention we provide a method of enabling a person to select a desired force-distance performance for a movable component of an apparatus, the method comprising:

providing a movable component having an actuator acting directly or indirectly on the movable component;

controlling the actuator to have a force-distance signature in accordance with a predetermined force-distance signature;

having the person operate the movable component whilst it has its force-distance signature controlled by the actuator, thereby enabling the person to determine whether the feel of the apparatus is acceptable.

Preferably the person manually operates the movable component. The actuator may control the movable component in accordance with a selected one of a plurality of predetermined force-distance signatures. The movable component may be moved by hand or foot. It may be possible to input a new force-distance signature, possibly using a keyboard, a graphical interface/graphical programmer, a user-manipulated electronic input, uploading of data, or by measuring signals generated by an acceptable component as it is moved.

Preferably the method comprises determining whether a user/driver-operated component meets a predetermined force-distance characteristic. The method may comprise enabling a person or computer to select the user-interface manipulation performance of one or more of the following:

a) a door latch mechanism
b) a hand brake mechanism
c) a clutch assembly/clutch pedal assembly
d) a footbrake assembly/footbrake pedal assembly
e) an acceleration pedal assembly
f) a gear stick assembly/gearbox assembly
g) a sunroof moving mechanism
h) a steering wheel
i) an indicator assembly
j) a switch assembly (e.g. a push switch, lever switch, or twist switch)
k) a glove box latch
l) a boot, bonnet or hood release latch assembly
m) a fuel flap release assembly.

The method may comprise having the person or some other movement means operate the movable component at a predetermined rate of operation or at a rate within acceptable limits thereto or at a predetermined force as a function of time (F(t)) or at a F(t) within acceptable limits thereto. The method may comprise determining whether the movable component is operated at the predetermined rate of operation or at a rate within acceptable limits thereto or at the predetermined force as a function of time (F(t)), or at a F(t) within acceptable limits thereto.

According to a fourth aspect of the invention we provide user-interface manipulation characteristic selection apparatus comprising a movable component whose user-interface manipulation characteristic is to be selected, movement-controlling means controlling the movement of the movable component, and control means adapted to control the movement-controlling means in accordance with a predetermined user-interface manipulation profile or signature.

The apparatus preferably has selection means adapted to select a chosen profile from a plurality of predetermined profiles. The control means and the selection means may comprise a computer and means to select from a menu of stored/predetermined manipulation profiles. Means to create or input a new profile may be provided, such as a keyboard, or graphical programmer. Means to manipulate or change an existing profile may be provided.

According to another aspect of the invention, we provide a method of determining the acceptability of an assembly having a movable component, the method comprising:

metrologically defining the movement of the movable component;

agreeing a metrological specification of acceptable user-interface movement characteristics;

manufacturing an assembly having a movable component;

demonstrating that said assembly has a measured movement characteristic that complies with the metrologically-defined user interface characteristic within an agreed/allowable margin of error.

The force-distance characteristics measured may be those of user-manipulated devices. The metrological specification of acceptable user-interface movement characteristics may include the rate of movement of the movable component and/or a force vs time specification for the movable component.

According to another aspect of the present invention there is provided a simulation apparatus which simulates release signatures of a latch mechanism having a handle movable from an inoperative position to an operative position.

The simulation apparatus may comprise simulation means adapted to be in contact with the handle of the latch mechanism and which produces forces on the handle dependent on the position thereof from its inoperative position.

The simulation apparatus may further comprise control means which generate control signals which are sent to the simulation means.

The simulation apparatus may further comprise means for providing a predetermined release signature which is sent to the control means which uses the release signature to generate the control signals.

According to another aspect of the present invention there is provided a simulation apparatus which simulates release signatures of a latch mechanism having a handle movable from an inoperative position to an operative position, the apparatus comprising means for providing a predetermined release signature, control means for receiving the release signature and generating therefrom control signals, and simulation means

adapted to be in contact with the handle of the latch mechanism which receives the control signals and produces forces on the handle dependent on the position thereof from its inoperative position.

The latch mechanism may be an automotive latch, or a non-automotive latch, for example a refrigerator door latch, or oven door.

According to a further aspect of the present invention there is provided a measurement apparatus which measures the release signature of a latch mechanism having a handle movable from an inoperative position to an operative position.

The measurement apparatus may comprise measurement means adapted to be connected to the latch mechanism which measures the force on the handle as a function of the position of the handle from its inoperative position.

The measurement apparatus may further comprise means which receive the force and distance measurements and generates a release signature therefrom.

The measurement apparatus may comprise force–time measurement means adapted to be connected to the latch mechanism which measures the force on the handle (or some component in the latch mechanism, for example a linkage) as a function of the time from the start of operation of the handle from its inoperative position. The force-time measurement means may comprise the measurement means adapted to be connected to the latch mechanism which measures the force on the handle as a function of the position of the handle from its inoperative position. Alternatively the force-time measurement means may be separate from the force-distance

measurement means. The force-time measurement means may comprise a transducer. The transducer may measure the force on the handle as a function of the time i.e. may measure the force and the time at/for which the handle experiences that force. Alternatively, the transducer may measure the force/forces experienced by the handle, and an additional time measurement means may be provided to measure the time at/for which the handle experiences a particular force. The time measurement means may be a computer. The force-time measurement means may further comprise means which receive the force and time measurements and generates a force-time signature/graph therefrom.

According to another aspect of the invention there is provided a measurement apparatus which measures the movement signature of a mechanism having a movable member movable from a first position to a second position, the apparatus comprising measurement means adapted to be connected to the movable member which measures the force on the member as a function of the position of the member, and receiving means which receives the force and distance measurement and generates a movement signature therefrom.

According to another aspect of the present invention there is provided a measurement apparatus which measures the release signature of a latch mechanism having a handle movable from an inoperative position to an operative position, the apparatus comprising measurement means adapted to be connected to the latch mechanism which measures the force on the handle as a function of the position of the handle from its inoperative position, means which receive the force and distance measurements and generates a release signature therefrom.

The measurement apparatus may be provided in a production line producing manually-operable mechanisms, with the measurement apparatus being adapted to test the mechanism produced to determine if their movable members meet predetermined movement signature characteristics.

We have appreciated that it is desirable to be able more completely to quantify manually-operated user-interface components where a user experiences a feedback, for example the release signature for a latch mechanism, by simulation or measurement, rather than relying on a single point test. If the release signature of a latch mechanism (or other movement vs force characteristic of another device) is measured and objectively quantified, it can then be agreed with the customer prior to design and manufacture of the latch mechanism (or other device), and latch mechanisms (or other device) can be checked to ensure that they fall within the customer's requirements. A tolerance band around the agreed curve can also be agreed with the customer.

The means for providing the release signature (or operation signature if it is not "releasing") of the simulation apparatus may comprise a computer such as a personal computer, and preferably a "laptop" computer. This providing means may also be used to modify the predetermined release signature (operation signature), or to display the release signature (operation signature) or to save the release signature (operation signature) in a memory. The release signature (operation signature) to be simulated may be selected from a number of signatures stored in a memory of the providing means. The release signature (operation signature) to be simulated may be generated by the providing means by a user or memory defining a number of force versus distance points through which the signature must pass, and the providing means

calculating the remainder of the points on the signature. The providing means preferably acts as an interface between a user and the control means. The providing means may be capable of initiating and issuing to the control means or simulation means an emergency stop and/or interrupt signals to stop and/or interrupt the action of the control means or simulation means.

The means which receive the force and distance measurements of the measurement apparatus may comprise a computer such as a personal computer, and preferably a "laptop" computer. This receiving means may be used to display the measured release signature (or other user-experienced signature) or to save the release signature (or other signature) in a memory. The receiving means may be capable of initiating and issuing to the measurement means an emergency stop and/or interrupt signals to stop and/or interrupt the action of the measurement means.

The control means of the simulation apparatus preferably uses a program to produce the control signals for the simulation means. The control means may be capable of initiating and issuing to the simulation means an emergency stop and/or interrupt signals to stop and/or interrupt the action of the simulation means. The control means may receive such signals from the providing means.

The measurement apparatus may further comprise control means used to control the measurement means, and which may receive the force and distance measurements from the measurement means and pass these to the receiving means. The control means may use a program to operate, for example to receive the force and distance measurements from the measurement means. The control means may receive electrical signals from the measurement means representative of the force and distance

measurements and may convert these into numerical values of the measurements for sending to the receiving means. The control means may use the program to do this conversion. The control means is preferably capable of initiating and issuing to the measurement means an emergency stop and/or interrupt signals to stop and/or interrupt the action of the measurement means. The control means may receive such signals from the receiving means.

The simulation means, measurement means, or both, may comprise an actuator. The actuator may be an electrical actuator, and is preferably an electrical, solenoid actuator. The actuator is preferably capable of linear operation. The actuator preferably comprises an actuating member, and can preferably generate more than one force at a given stroke of its actuating member. The actuator may incorporate an optical encoder. The encoder may be attached to the actuating member. The encoder may be used, in the measurement apparatus, to generate the distance measurements. The actuator may be connected to the control means of the simulation and/or measurement means. In the simulation apparatus, the actuator may be in contact with the handle of the latch mechanism. In the measurement apparatus, the actuator may be in contact with any part of the latch mechanism. It may be directly in contact with the latch mechanism or handle, or may be in contact therewith via a link such as a mechanical link which may be a lever or a cable. In the measurement apparatus, the actuator may be used to measure the force and distance measurements, or just the force measurements or just the distance measurements. When used to measure the distance measurements alone, the measurement means may further comprise a load cell which is used to measure the force measurements. The actuator may use magnetic means to measure the force, a current in the actuator may be representative of the force which may be sent to the control means.

The simulation and measurement apparatus can simulate/measure a release (or other) signature assuming that the handle (or other movable component) is operated at a constant speed, or assuming that it is operated at a non-constant speed. The time for which a certain force is applied to the handle of a latch mechanism (or other movable component of an assembly) may also be measured. At each distance travelled by the handle (or movable component), the force on the handle (component) and/or the time from the start of the operation of the handle (component) may be measured.

The handle of the latch mechanism (or the other movable component) with which the simulation apparatus is in contact for use may comprise a return spring. The simulation means preferably is able to simulate the effect of the spring on the feel of the handle (component). In use, the simulation apparatus may be attached to an actual door, for example a vehicle door, or may be attached to a mock-up of such a door which may be designed to look like a normal door. The simulation means and the control means are preferably received within the door or mock-up, leaving only the means for providing the release signature of the apparatus exposed for use by the latch mechanism manufacturer and visible to the customer. The vehicle door may be attached to a vehicle. The manufacturer may then sit in the vehicle or be positioned close to the vehicle and may simulate a number of latch mechanism signatures with the customer present who may operate the handle determining which feel is required/desirable for the vehicle.

The customer may be able to select the desired signature from an available menu of signatures, or design their own (possibly there and then at the door/vehicle, when the signature is a vehicle door latch release signature).

Of course, when selecting a desired operational characteristic for a non-vehicle application it is envisaged that the actuator be hidden from view so that the overall assembly appears normal to the user. For example, we would envisage a refrigerator door with a computer-controlled actuator in it looking like a normal refrigerator door, a seat with spring support for the seat (but replaced by a computer-controlled actuator) looking like a normal seat, etc.

The measurement apparatus may be used to measure the release signature (or other operational signature) of manufactured latch mechanisms (other movable components), to check that these lie within requirements set by the customer. A measurement apparatus may be installed at the end of a production line of the latch mechanisms (or other components), so that testing and rejection, if necessary, may take place at that point. The measurement apparatus may also be used to test competitors' latch mechanisms (or other components), and this could be useful in determining any flaws in such mechanisms. The measurement apparatus may measure the release signature of a latch mechanism mounted on an actual door, or mounted on a test rig. The test rig may be fixed or portable. The measurement apparatus may include a test rig. The test rig may comprise a spring used to simulate the load produced by the seal of a door. It is preferably possible to change the stiffness of the spring, and hence use the measurement apparatus to measure the effect of changing the seal of a door on the feel generated at the handle of the door. The spring may have its stiffness and/or other characteristics controlled/simulated by the measurement apparatus.

The simulation and/or measurement apparatus may be used on inside or outside latch mechanisms of a door or both (e.g. a vehicle door). Inside

and outside handles may be tested. These may have the same or different latch mechanisms.

The simulation and measurement apparatus may also be used to simulate/measure the noise produced on operation of a latch mechanism (for example upon opening, or upon closing - indeed it could simulate the "clunk" of a whole door closing to enable the user to select from a variety of sounds/feels). The door hinge could be controlled/replaced by an actuator to simulate different door hinge/linkages, preferably in a programmable/selection from memory, way. Noise producing/detecting means may be provided.

Although the above description has been directed towards simulating/measuring the release signature of a vehicle door latch, the apparatus can be used to measure other operation characteristics of other devices, which need not be automotive-related, and need not be latches. It could also be used in relation to other components of doors, such as door hinges, or door closing mechanisms (for example those that close the door of a room automatically). For example, the apparatus could be used to quantify the feel of a vehicle foot brake, or hand brake, or clutch pedals, or of gear levers, or of a vehicle boot/hatchback (which can be considered as doors). The feel of a steering wheel and steering system response could be simulated, as could the feel of a sunroof-opening mechanism.

According to another aspect of the present invention there is provided an automotive vehicle incorporating a simulation apparatus according to any preceding aspect of the invention.

The simulation apparatus or at least a part thereof is preferably incorporated into the vehicle body (or other larger whole-machine/pseudo whole-machine assembly) such that it is hidden from view, at least when a customer is testing the handle. Preferably the simulation apparatus can be operated to provide a number of release signatures in a matter of seconds/minutes. The customer can then quickly try out a number of different handle feels. For example, a typical desired simulation rate may be 2 simulations per minute, but 1 per minute, 1 every 2 minutes, 1 every 5 minutes, or longer, may be acceptable.

According to another aspect of the present invention there is provided a door incorporating a simulation apparatus according to the first aspect of the invention.

According to another aspect of the present invention there is provided a simulation apparatus for a foot brake assembly.

According to another aspect of the present invention there is provided a simulation apparatus for a hand brake assembly.

According to another aspect of the present invention there is provided a simulation apparatus for a clutch pedal assembly.

According to another aspect of the present invention there is provided a simulation apparatus for an accelerator assembly.

According to another aspect of the present invention there is provided a simulation apparatus for a gear stick/gear mechanism assembly.

These apparatus may comprise simulation means, control means, and/or providing means as above.

A method of accepting an order to manufacture an assembly having a movable component, the method comprising:

Specifying an acceptable movement characteristic of the movable component in objective measurable terms, and agreeing that assemblies will be made that have movable components with movement characteristics that fall within the agreed terms.

This enables the person placing the order and the person making the assembly to agree whether the assemblies that are made have acceptable movable component measurement characteristics or not, when hitherto it has been a subjective opinion as to whether they "feel" right.

The aspects of the invention can also be expressed as methods, and we seek protection for methods of simulating/measuring vehicle door latch mechanism release signatures, and simulating foot brake, hand brake, clutch pedal, accelerator and gear stick/ gear mechanism assembly signatures, steering wheel and sunroof signatures, to name only some user-manipulated assemblies which have a "feel"/feedback to the user, and we seek protection for any such simulating/measuring apparatus or methods.

Embodiments of the present invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of a simulation apparatus according to the first aspect of the present invention;

Figure 2 is a flow chart showing the operation of the simulation apparatus;

Figure 3 is a schematic representation of a measurement apparatus according to the second aspect of the present invention;

Figure 4 is a flow chart showing the operation of the measurement apparatus;

Figure 5 is a schematic representation of a vehicle door incorporating a simulation apparatus according to the first aspect of the invention;

Figure 6 is a schematic representation of a vehicle door incorporating two simulation apparatus, one for simulating a release signature on the outer handle of the door, and one for simulating a release signature for the inner handle of the door;

Figure 7 is a schematic representation of a vehicle fitted with simulators for driver-experienced operated mechanical components;

Figure 8 shows more detail of a typical door latch mechanism release signature;

Figure 9 shows a design-to-prototype manufacture process which uses the present invention; and

Figure 10 is a schematic representation of a measurement apparatus according to the eighth aspect of the present invention.

Figure 1 shows a simulation apparatus comprising simulation means 1, control means 2 and providing means 3. The simulation means comprises an actuator 4 which is an electrical, solenoid type actuator having an actuating member 5. This is in contact, in this example, with the handle 6 of the latch mechanism of a vehicle door (not shown). The actuator is further connected via a cable to the control means 2. The control means is, in turn, connected to the providing means 3. This comprises a laptop computer, which stores a number of latch mechanism release signatures in its memory. The controller is further connected to a release actuator 7 which is in contact with and operates the latch 8 of the latch mechanism.

Figure 2 shows a flow chart of the operation of the simulation apparatus. In use, a user chooses a release signature to simulate from the memory of the computer, or defines a signature to be simulated. This is displayed by the computer. The force versus distance points of the signature are then sent to the control means 2. A program is stored within this, and is used to convert the data from the computer into control signals. These are sent to the actuator 4 and to the actuator 7, starting the simulation of the release signature. The actuator 4 uses the control signals to produce a particular force on the handle 6 of the latch mechanism as a function of the distance of the handle from its inoperative position. When a user operates the latch mechanism, the feel of the handle is determined by the release signature selected or defined. The control signals are also sent to the release actuator 7 which operates to release the latch 8 of the latch mechanism and open the door. The user is not aware that the latch 8 has been released by the release actuator 7, the impression is that operation of the handle 6 has opened the door. When all the control signals have been produced and sent to the actuator, the simulation ends and control of the latch mechanism is returned to the user. A number of signatures can be

selected/defined, the user/customer deciding which produces the best feel. This process can take place in a few hours - changing the feel of the latch mechanism can be achieved in seconds - the time the customer takes to make up their mind which they like best/which is acceptable is the limiting factor.

Figure 3 shows a measurement apparatus comprising measurement means 20, control means 21 and receiving means 22. The measurement means comprises an actuator 23 which is an electrical, solenoid type actuator having an actuating member 24. This is in contact with the latch 25 of a latch mechanism of a vehicle door. The actuator 23 is further connected via a cable to the control means 21. The control means is, in turn, connected to the receiving means 22. This comprises a laptop computer, which can store a number of latch release signatures in its memory.

Figure 4 shows a flow chart of the operation of the measurement apparatus. In use, a user inputs parameters for the measurement operation into the computer, e.g. concerning which type of latch mechanism is being tested. These are sent to the control means 21, and the measurement operation is started. A user or automatic means operates the latch mechanism. The force on this will vary according to the distance of the handle of the mechanism from its inoperative position. The actuator 23 measures the force and distance, and transfers this data to the control means 21. The computer receives the measurements from the control means in real time, and stores the measurements. The control means 21 stops the measurement operation, according to the parameters of the operation input into the computer. The computer then translates the force and distance measurements into a release signature and displays the

signature on its screen for analysis. The release signature may be stored for future use.

Figure 5 shows a vehicle door 30 incorporating a simulation apparatus comprising simulation means and control means 31 housed between inner and outer panels 32,33 of the door. The control means 31 is connected to providing means 34 which is external to the door, for access by a user of the apparatus. The simulation means comprises an actuator 35 in contact with the handle 36 of the latch mechanism of the door. A release actuator 37 is also housed within the door, this operates the latch 38 of the latch mechanism. The customer cannot see the apparatus within the door - the door looks as normal. The providing means 34 is a control computer which may communicate with the simulation apparatus via a wired connection, or via electromagnetic, non-wired connection.

Figure 7 shows a vehicle door 40 for use with two simulation apparatus. A first simulation means and a first control means 42 of a first simulation apparatus is housed between outer 43 and inner 44 panels of the door. The control means 42 is connected to a first providing means 45 external to the door for access by a user. The first simulation means comprises an actuator 46 in contact with the outer handle 47 of the door, and the first simulation means simulates release signatures for this handle. A first release actuator 48 is connected to the first control means 42 and operates the latch 49 of the latch mechanism for the outer handle. A second simulation means and a second control means 50 of a second simulation apparatus is housed between the outer and inner panels of the door. The control means 50 is connected to a second providing means 51 external to the door for access by a user. The second simulation means comprises an actuator 52 in contact with the inner handle 53 of the door, and the second simulation means simulates release signatures for this handle. A second

release actuator 54 is connected to the second control means 50 and operates the latch 55 of the latch mechanism for the inner handle. Again, the user does not see any of the components housed within the door.

Figure 7 shows a car 80 provided with a simulation apparatus 82 hidden in its door 84. Also shown schematically are simulation apparatus 86 (foot brake), 88 (hand brake), 90 (steering), 92 (clutch pedal), 94 (brake pedal), 96 (accelerator), 98 (boot catch) and 100 (bonnet catch). We could typically provide the car 80 with only one of the apparatus at one time, but we could provide any two, three, or more of them at the same time, or indeed all of them. The control computer (referenced 102) could be used inside the vehicle, possibly by someone sitting next to the driver/customer (or the customer could operate themselves), or outside the vehicle.

Figure 8 shows more detail of a door latch assembly release signature, including what is happening at various portions of the curve.

Figure 9 shows that after a customer has decided upon a desired release signature we can, if we desire, design on computer the mechanical components of the door handle latch mechanism, and predict what release signature they will have, which we can ensure is close enough to the customer selected/defined release signature to be acceptable within objectively measured limits. We can then, if we wish, have a customer re-test the designed new latch mechanism using the simulation apparatus controlled by the predicted signature of the newly-designed mechanism (or we can omit this stage). We can then make a latch mechanism and test it/validate it to demonstrate to the customer that it does indeed have the agreed release signature.

It will be appreciated that where a user applies a force to a movable component there will be a "feel" or physical feedback to the user from the resistance to movement of the component. This may feel good, bad, or indifferent to the user, and different users may have different perceptions. By quantifying this resistive feedback (which typically changes with the distance through which the movable component is moved) we allow a more objective setting of the force-distance performance of person-moved movable components to be achieved. By offering the designer of a system having a movable component a chance to try out several user-interface force-distance resistive feedback settings/signatures for a movable component we assist the designer in achieving the best design, and may enable consumer trials to be performed prior to expensive production of prototypes.

Figure 10 shows a measurement apparatus comprising an actuator 100 which is an electrical, solenoid type actuator having an actuating member 101. This is in contact with a lever 102 which is linked via a latch transducer 103 to the latch 104 of a latch mechanism 105 of, for example, a vehicle door. The ratio of lever 102 can be changed to suit different latch mechanisms, to achieve the movement required on the latch of the latch mechanism. The latch mechanism is connected to a spring 106 which simulates the seal load on the door. A seal load transducer 107 and measurement device 108 measures this seal load, which is adjustable via a seal load screw 109. The actuator 100 is connected via a cable to control means 110. The latch transducer is also connected to the control means 110. The control means is, in turn, connected to receiving means 111. This comprises a laptop computer. In operation, a seal load on the latch mechanism is set. The latch 104 is operated i.e. moved from its inoperative position to a fully operative position. During movement, the actuator measures the force on the latch

as a function of its distance from the inoperative position, and the transducer measures the force on the latch. The force-distance measurements and the force measurements are transferred to the control means 110, and from there to the receiving means. The receiving means uses the force measurements to determine force-time measurements, and a rate of operation of the latch, and uses the force-distance measurements to determine a force-distance signature. Such an apparatus can be used to determine if a movable component, such as a latch, has a desired force-distance signature at a predetermined rate of operation of the component, or predetermined force applied to the handle as a function of time.

CLAIMS

1. A method of determining whether an apparatus having a movable component meets predetermined movement characteristics, the method comprising the steps of:

establishing a predetermined movement signature for said movable component;

moving said movable component through a distance;

measuring the movement signature of the movable component;

establishing whether the measured movement signature matches the required predetermined movement signature to within acceptable limits.

2. A method according to claim 1 wherein the movement characteristic comprises a force-distance characteristic signature, the movement signature comprises a force-distance signature, and the movement signature measured comprises a force-distance signature.

3. A method according to claim 1 or claim 2 wherein the component is moved by human action.

4. A method according to any preceding claim wherein the component is moved by the hand or foot.

5. A method according to any preceding claim in which the predetermined movement characteristic signature is established or created by inputting data to a memory using one or more of: a keyboard, a graphic interface, user-manipulated electronic input, or uploading of data.

6. A method according to any preceding claim in which the predetermined movement signature has a plurality of points on the force-distance graph.

7. A method according to any preceding claim which comprises determining whether a driver-operated component of an automotive vehicle meets a predetermined force-distance characteristic.

8. A method according to any preceding claim in which the movable component comprises one or more of the following:

a) a door latch mechanism
b) a hand brake mechanism
c) a clutch assembly/clutch pedal assembly
d) a footbrake assembly/footbrake pedal assembly
e) an acceleration pedal assembly
f) a gear stick assembly/gearbox assembly
g) a sunroof moving mechanism
h) a window moving mechanism
i) a steering wheel
j) an indicator assembly
k) a switch assembly (e.g. push switch, deflect switch or twist switch)
l) a glove box latch
m) a boot, bonnet or hood release latch assembly
n) a fuel flap release assembly.

9. A method according to any one of claims 1 to 7 which comprises determining whether a door latch assembly meets a predetermined force-distance characteristic.

10. A method according to any preceding claim in which the movement signature of the movable component is measured by moving the movable component through said distance by automated component-moving means.

11. A method according to any preceding claim in which a processor compares the measured force/distance signature with a predetermined allowable signature from memory.

12. A method according to claim 11 in which the processor also controls the movement of the movable component.

13. A method according to any preceding claim which comprises establishing a predetermined rate of moving the movable component or establishing a predetermined force applied to the component as a function of time (F(t)), moving the movable component at that rate or at that F(t), or a rate or F(t) within acceptable limits thereto, and establishing whether the measured force-distance signature matches the required predetermined force-distance signature to within acceptable limits at the rate of moving or the F(t) applied to the component.

14. A method according to claim 13 which comprises determining whether the movable component is moved at the predetermined rate of moving or F(t) or a rate or F(t) within acceptable limits thereto.

15. Force -vs- distance measuring apparatus adapted to determine whether a movable component has a predetermined acceptable force -vs- distance movement characteristic: the apparatus comprising signature capture means for measuring or acquiring the force-distance signature of said component; and comparator means adapted to compare the measured or acquired force -vs- distance signature with an allowable force -vs- distance signature.

16. Apparatus according to claim 15 which further comprises response means adapted to respond in different predetermined ways if a component either meets the predetermined requirements or if it fails to meet the requirement.

17. Apparatus according to claim 15 or claim 16 in which the signature capture means comprises measurement means adapted to measure the force on the movable component as a function of its position.

18. Apparatus according to claim 17 which comprises receiving means which receives the force-distance data and which is adapted to determine a measured force-distance signature.

19. Apparatus according to any one of claims 15 to 18 which is adapted to measure the release signature of a latch mechanism having a handle movable from an inoperative position to an operative position, the signature capture means comprising measurement means adapted to be connected to the latch mechanism (or related to the latch mechanism) which measures the force on the handle as a function of the position of the handle from its inoperative position, and receiving means which receives

the force and distance measurements and generates a release signature curve therefrom.

20. Apparatus according to any of claims 15 to 19 in which the receiving means is used to save the release signature in a memory.

21. Apparatus according to any of claim 15 to 20 in which the apparatus is used to measure the release signature of previously manufactured latch mechanisms (or operational performance of precisely manufactured other articles), to check that these lie within predetermined boundaries.

22. Apparatus according to any of claims 15 to 21 in which the apparatus is installed in a production line, so that testing and rejection, if necessary, takes place at that point.

23. Apparatus according to any of claims 15 to 22 in which the apparatus is adapted to measure the release signature of a latch mechanism mounted on a vehicle door, or in which the apparatus is adapted to measure the release signature of a latch mechanism mounted on a test rig; or the operational performance of an article mounted on a test rig.

24. Apparatus according to claim 23 in which a test rig is provided and in which the test rig comprises a spring used to simulate a biasing load applied to the movable component.

25. Apparatus according to claim 24 in which it is possible to change the stiffness of the spring.

26. Apparatus according to any one of claims 15 to 25 which has a solenoid actuator and/or sensor.

27. Apparatus according to claim 26 wherein the actuator comprises an actuating member, and can generate more than one force at a given stroke of its actuating member.

28. Apparatus according to any of claim 26 or claim 27 wherein the actuator has an optical encoder.

29. Apparatus according to any one of claims 26 to 28 wherein the actuator is connected to control means, or measurement means, and connected directly or indirectly via a link to a latch mechanism.

30. Apparatus according to any one of claims 26 to 29 wherein the actuator is used to measure the force measurements and not the distance measurement, or the distance measurement and not the force measurement.

31. Apparatus according to claim 30 wherein the measurement means further comprises a load cell which is used to measure the force measurements.

32. Apparatus according to any of claims 15 to 31 wherein movement means is provided for enabling the movable component to be moved at a predetermined rate of moving, or at a predetermined force as a function of time (F(t)), or at a rate or F(t) within acceptable limits thereto.

33. Apparatus according to any of claims 15 to 32 which comprises mounting means for determining whether the movable component is moved at the predetermined rate of moving or a rate within acceptable limits thereto, or at the predetermined F(t) or at a F(t) within acceptable limits.

34. Apparatus according to any of claims 15 to 33 wherein force–time measurement means is provided adapted to be connected to the movable component and to measure the force on the component as a function of time.

35. Apparatus according to claim 34 wherein a transducer is provided to measure, in use, the force/forces experienced by the component, and an additional time measurement means is provided to measure the time at/for which the component experiences a particular force.

36. Apparatus according to claim 34 or claim 35 wherein the force-time measurement means further comprises means which receive the force and time measurements and generates a force-time signature/graph therefrom.

37. A method of determining the acceptability of an assembly having a movable component, the method comprising:

metrologically defining the movement of the movable component

agreeing a metrological specification of acceptable user-interface movement characteristics;

manufacturing an assembly having a movable component;

establishing that said assembly has a measured movement characteristic that complies with the metrologically-defined user interface characteristic within an agreed/allowable margin of error.

38. A method according to claim 37 in which force-distance characteristics of user-manipulated devices are measured.

39. A method according to claim 37 or claim 38 in which the metrological specification of acceptable user-interface movement characteristics includes the rate of movement of the movable component or the force as a function of time applied to effect the movement.

40. A measurement apparatus which measures the release signature of a latch mechanism having a handle movable from an inoperative position to an operative position.

41. A measurement apparatus according to claim 40 which comprises measurement means adapted to be connected to the latch mechanism which measures the force on the handle as a function of the position of the handle from its inoperative position.

42. A measurement apparatus according to claim 40 or claim 41 which further comprises means which receive the force and distance measurements and generates a release signature therefrom.

43. A measurement apparatus according to any of claims 40 to 42 which comprises force–time measurement means adapted to be connected to the latch mechanism which measures the force on the handle as a

function of the time from the start of operation of the handle from its inoperative position.

44. A measurement apparatus according to claim 43 as dependent from claim 41 in which the force-time measurement means comprises the measurement means adapted to be connected to the latch mechanism which measures the force on the handle as a function of the position of the handle from its inoperative position.

45. A production line adapted to produce assemblies having a movable member, the production line having measurement apparatus according to any one of claims 15 to 36 or 40 to 44, or operating in accordance with any one of claims 1 to 14 or 37 to 39, and adapted to test assemblies made by the production line to ensure that the movable member meets predetermined movement characteristics.

46. A computer product or programme element which when operating on a computer causes the computer to execute procedure to perform a method in accordance with any preceding method claims, or to provide simulation apparatus or measurement apparatus in accordance with any preceding apparatus claim.

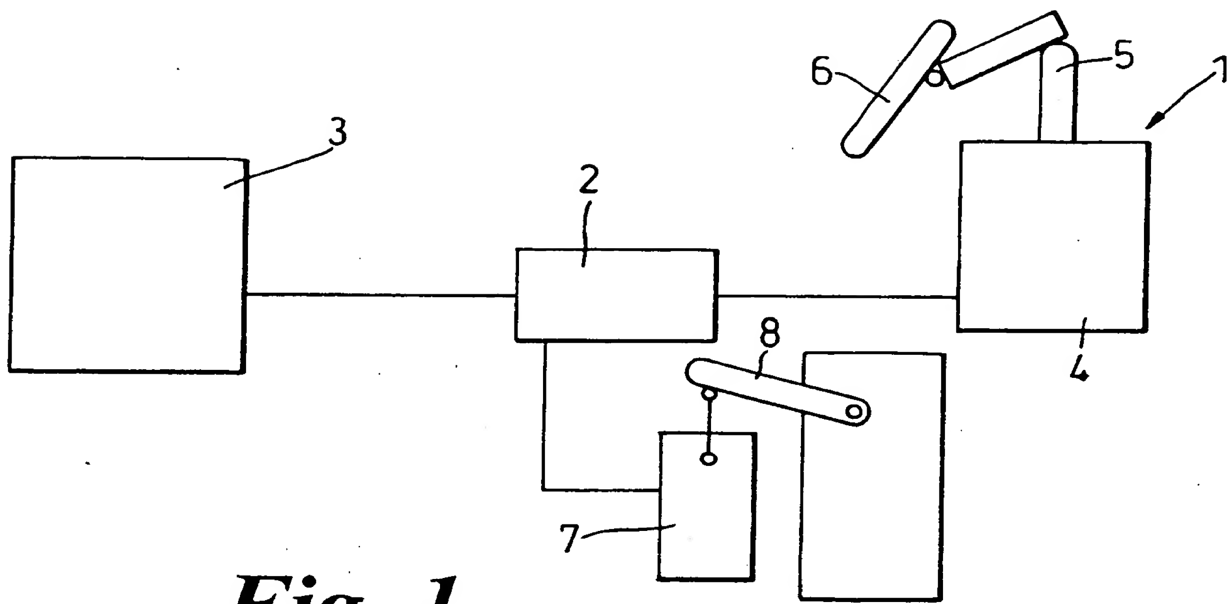


Fig. 1

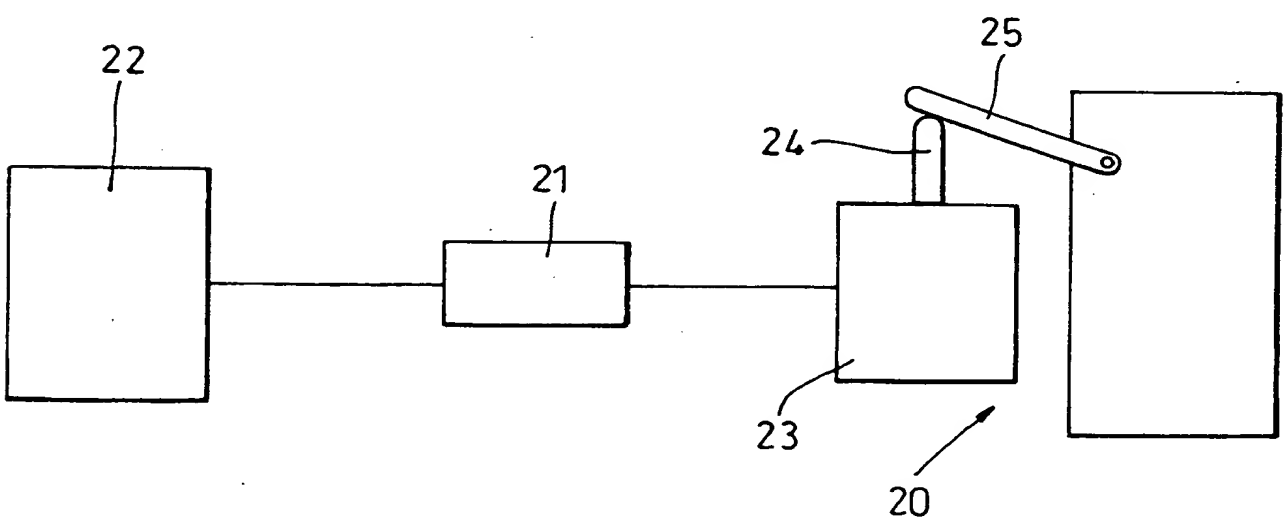


Fig. 3

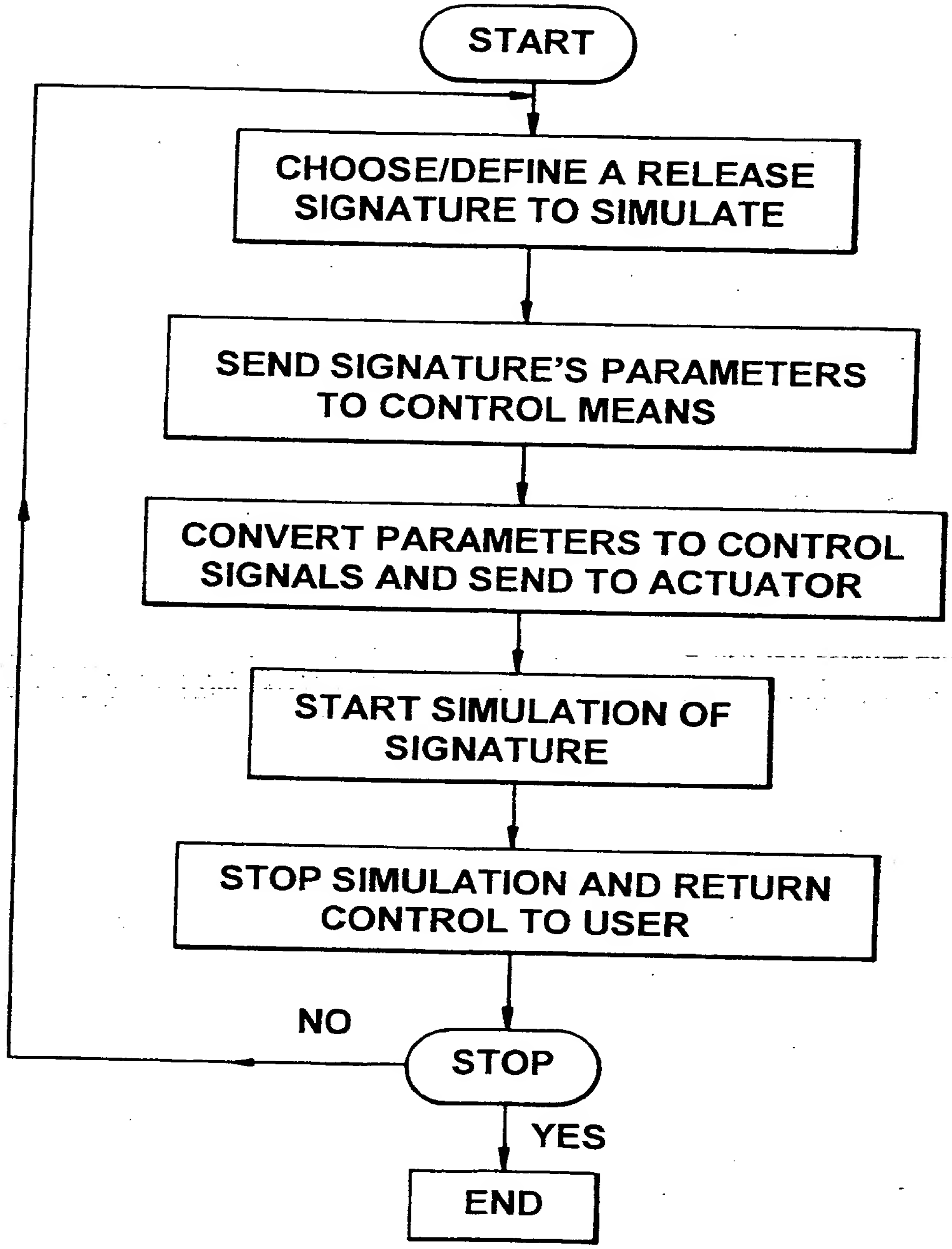

START
CHOOSE/DEFINE A RELEASE SIGNATURE TO SIMULATE
SEND SIGNATURE'S PARAMETERS TO CONTROL MEANS
CONVERT PARAMETERS TO CONTROL SIGNALS AND SEND TO ACTUATOR
START SIMULATION OF SIGNATURE
STOP SIMULATION AND RETURN CONTROL TO USER
NO
STOP
YES
END

Fig. 2

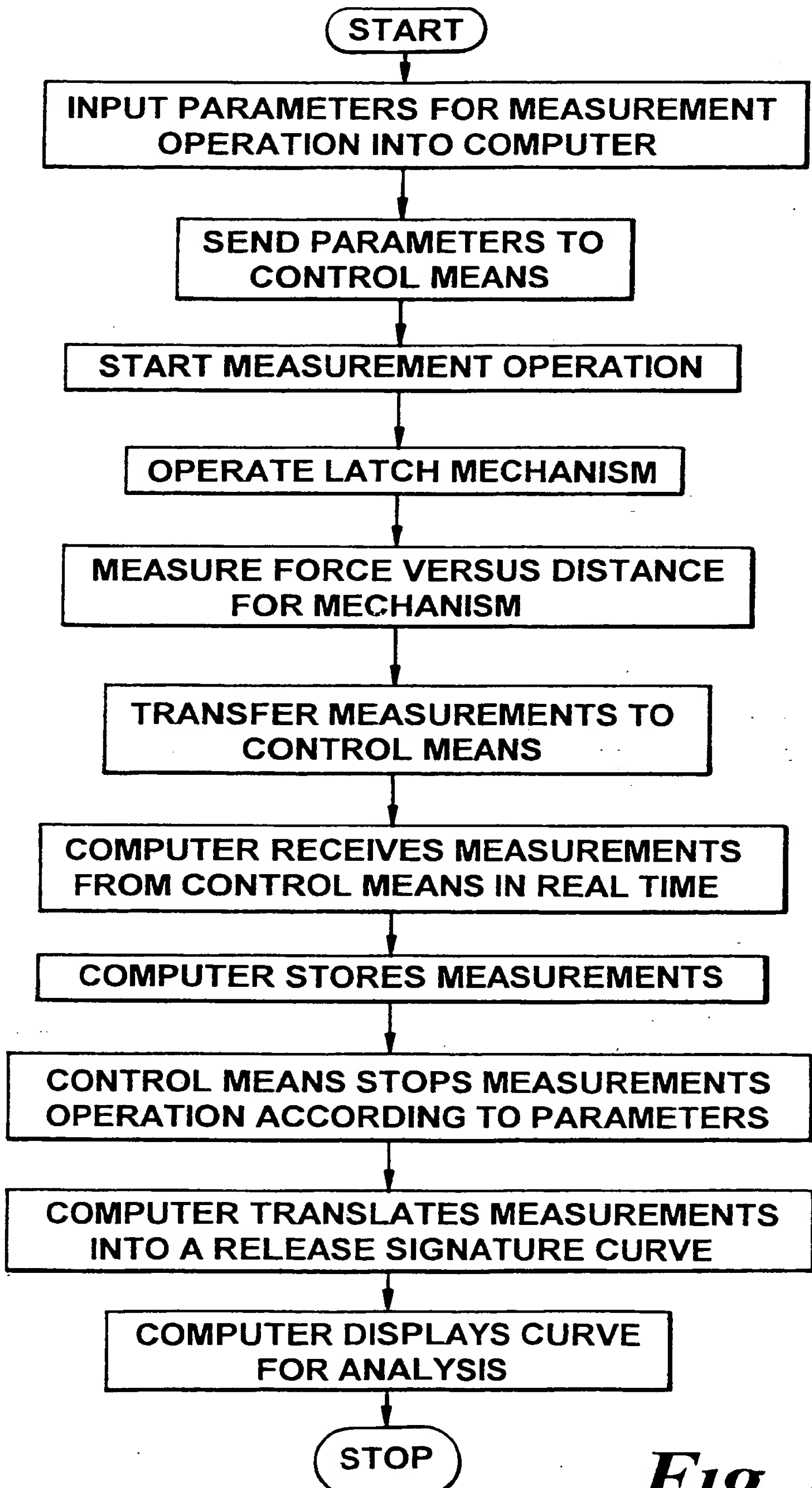

START
INPUT PARAMETERS FOR MEASUREMENT OPERATION INTO COMPUTER
SEND PARAMETERS TO CONTROL MEANS
START MEASUREMENT OPERATION
OPERATE LATCH MECHANISM
MEASURE FORCE VERSUS DISTANCE FOR MECHANISM
TRANSFER MEASUREMENTS TO CONTROL MEANS
COMPUTER RECEIVES MEASUREMENTS FROM CONTROL MEANS IN REAL TIME
COMPUTER STORES MEASUREMENTS
CONTROL MEANS STOPS MEASUREMENTS OPERATION ACCORDING TO PARAMETERS
COMPUTER TRANSLATES MEASUREMENTS INTO A RELEASE SIGNATURE CURVE
COMPUTER DISPLAYS CURVE FOR ANALYSIS
STOP

Fig 4

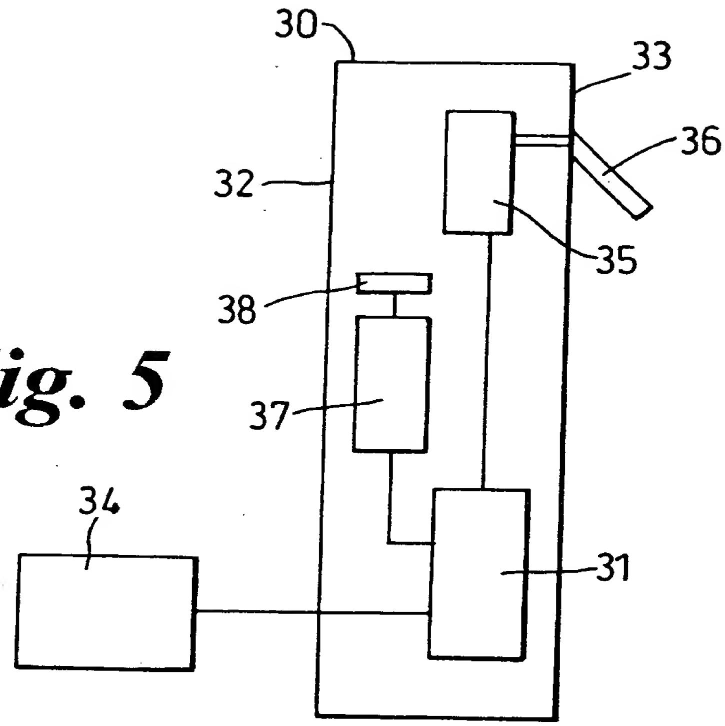


Fig. 5

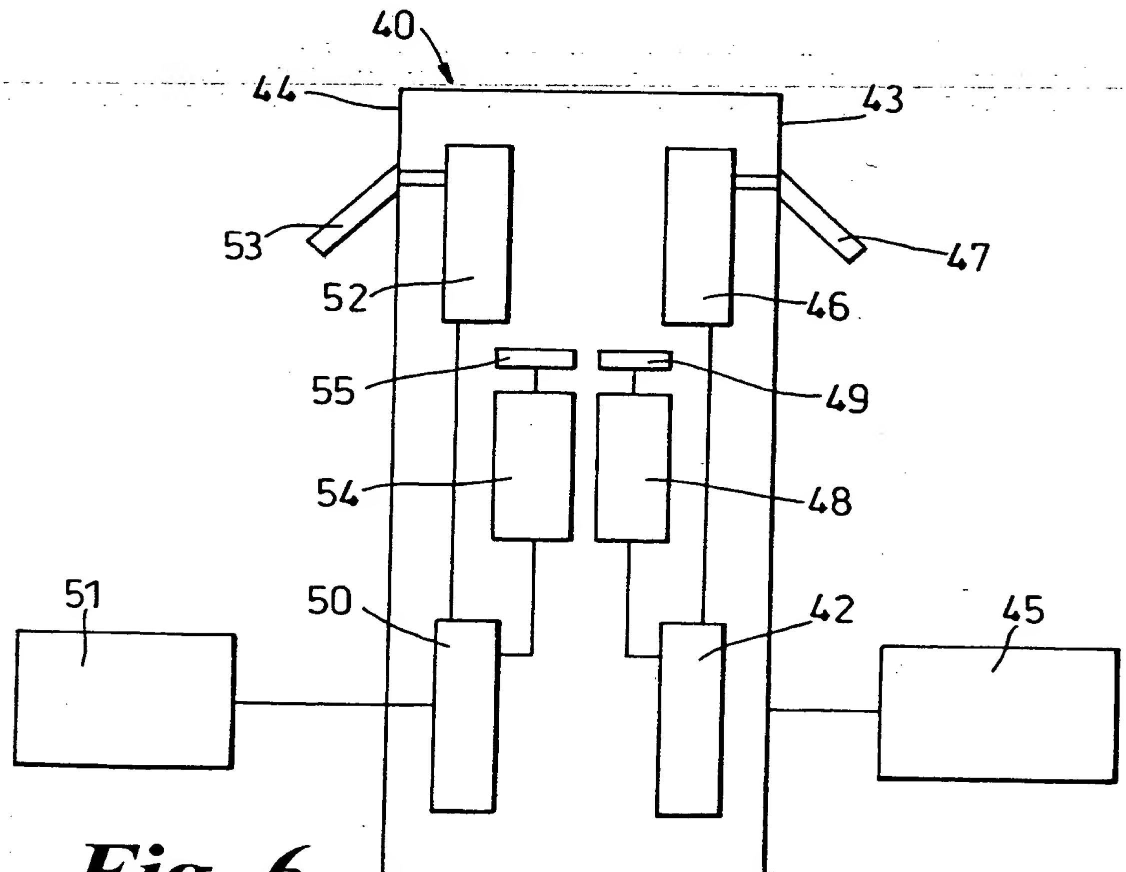


Fig 6

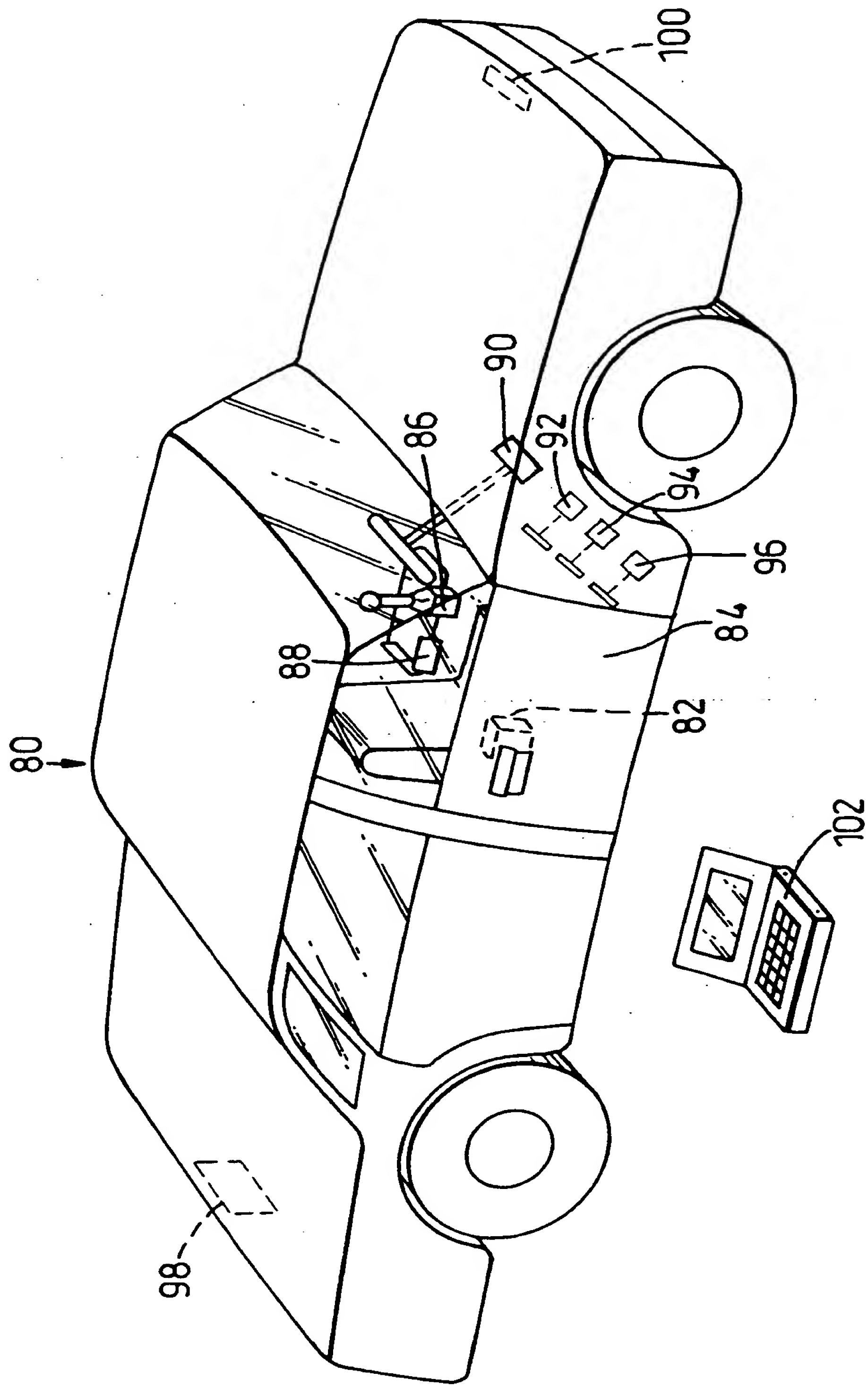
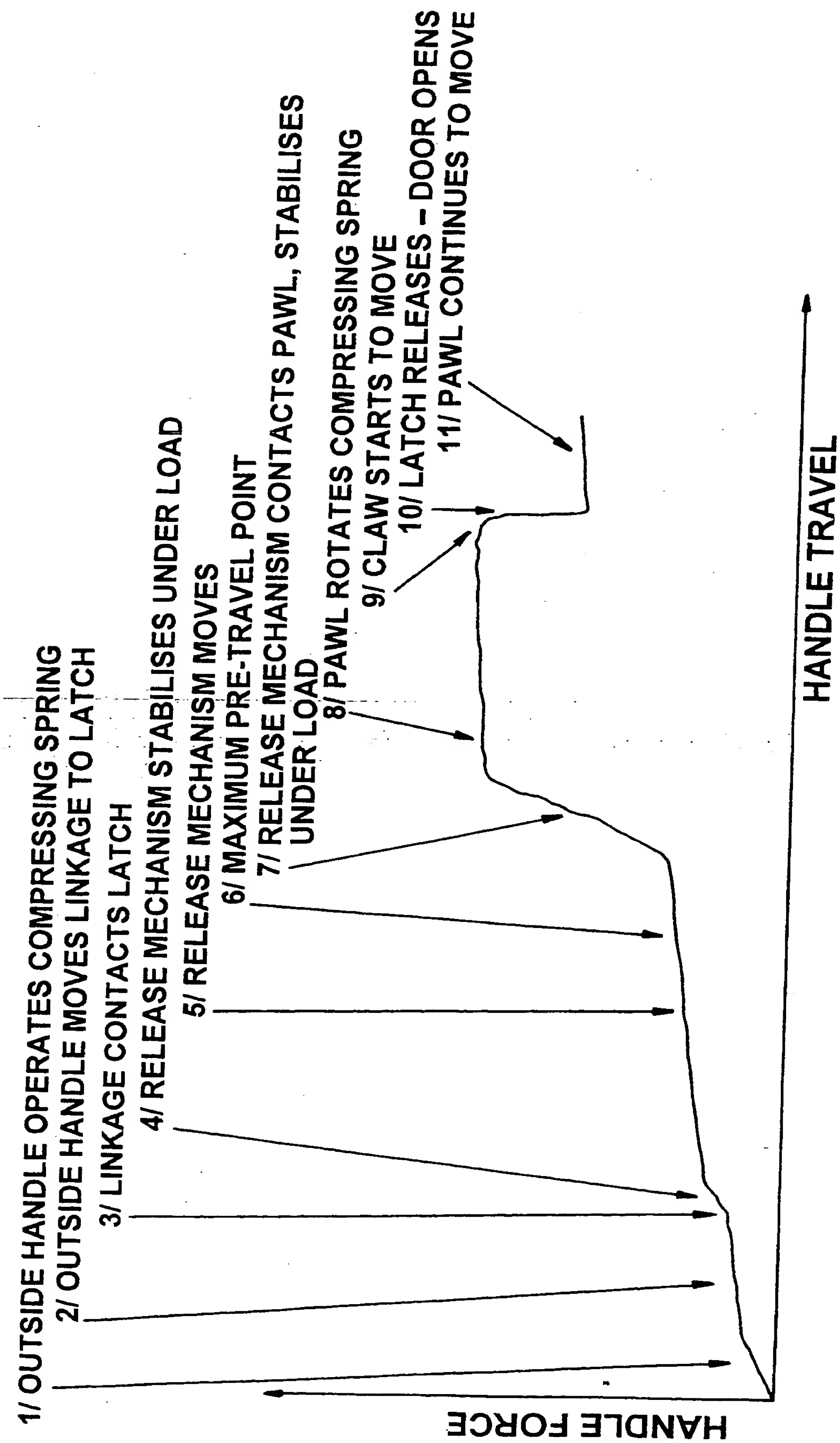


Fig. 7

6/8



TYPICAL RELEASE GRAPH OF FORCE Vs TRAVEL

Fig 8

7/8

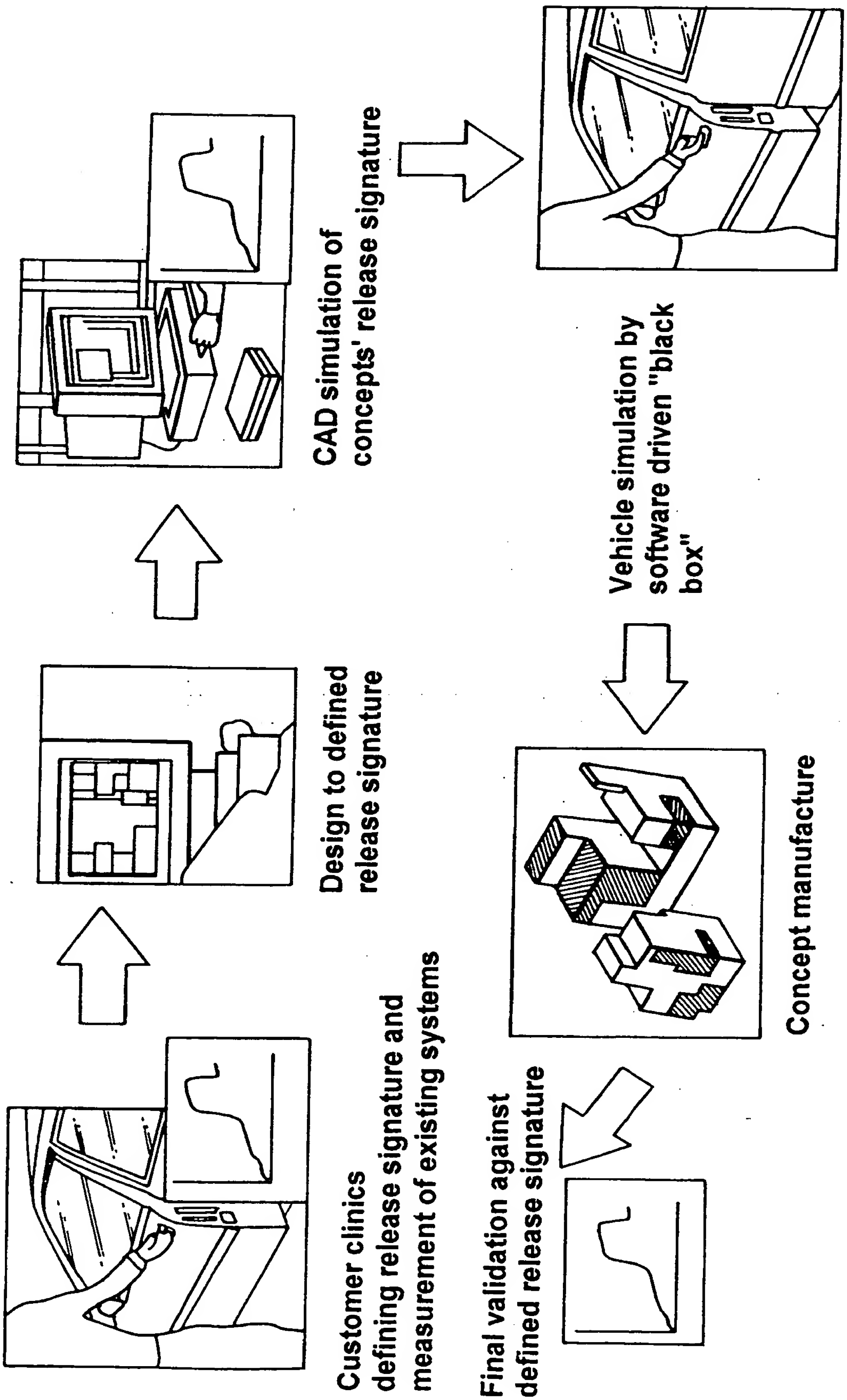

Customer clinics defining release signature and measurement of existing systems
Design to defined release signature
CAD simulation of concepts' release signature
Vehicle simulation by software driven "black box"
Concept manufacture
Final validation against defined release signature

Fig. 9

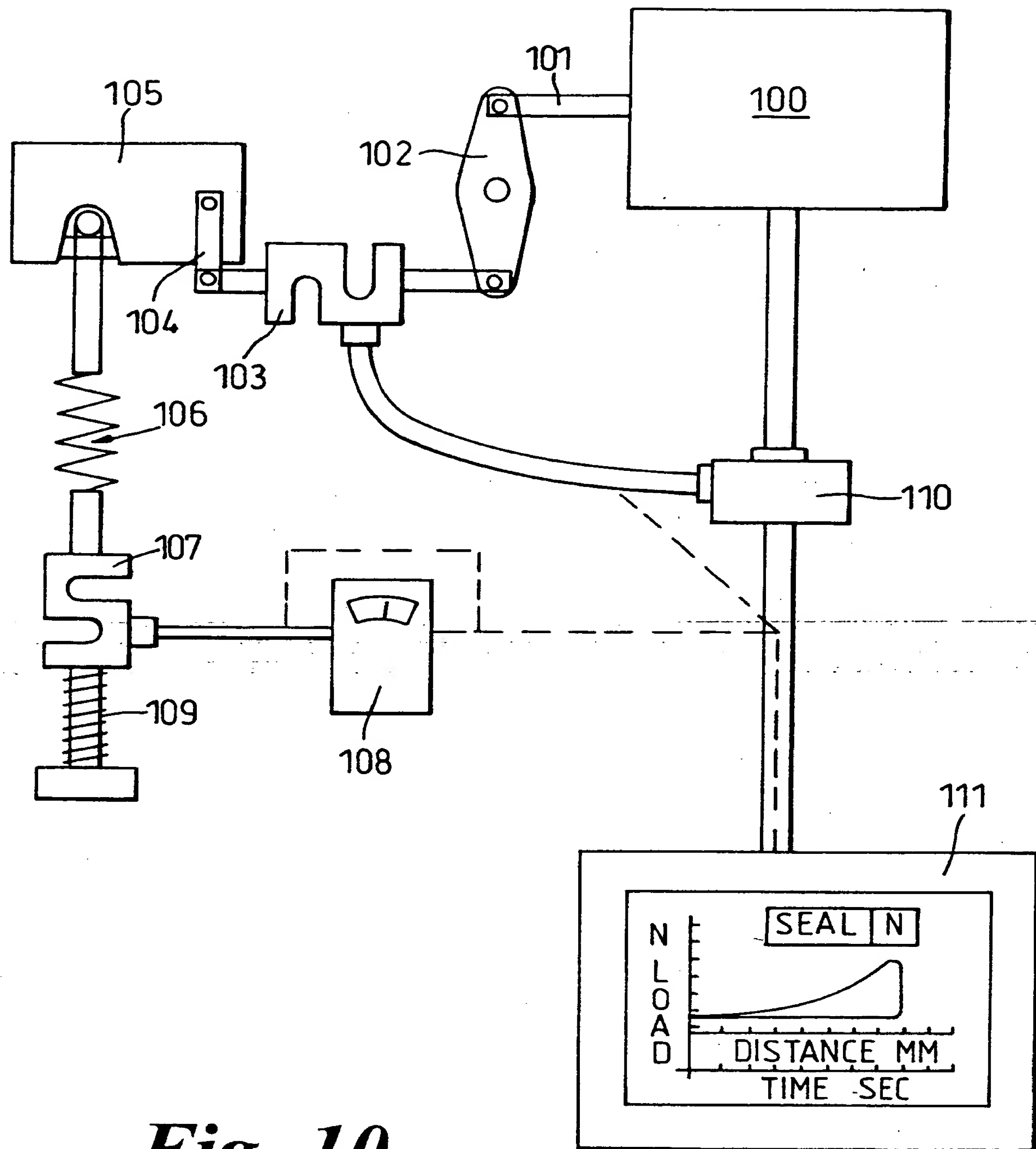

100
101
102
103
104
105
106
107
108
109
110
111
SEAL
N
N
LOAD
DISTANCE MM
TIME SEC

Fig. 10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/00027

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01L5/22 G01M17/00 E05B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E05B G01L G01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 252 826 A (JAGUAR CARS LIMITED) 19 August 1992 (1992-08-19)	1,2,5, 7-11, 15-23, 32, 40-42, 45,46
A	the whole document	30,31
X	US 5 627 767 A (GABINIEWICZ ET AL.) 6 May 1997 (1997-05-06) column 1, line 52 -column 2, line 7 column 6, line 11-15 column 7, line 47-52 column 13, line 41-64 column 15, line 42 -column 16, line 37	1,2, 5-23, 32-37, 40-46

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 May 2000	18/05/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Westin, K

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/00027

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2252826 A	19-08-1992	NONE	
US 5627767 A	06-05-1997	AU 4780496 A	11-09-1996
		CA 2213218 A	29-08-1996
		WO 9626421 A	29-08-1996